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1 Navy Case No. 76846

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3 A ROTARY PUMP SYSTEM

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5 STATEMENT OF GOVERNMENT INTEREST

6 The invention described herein may be manufactured and used
7 by or for the Government of the United States of America for
8 governmental purposes without the payment of royalties thereon or
9 therefor.

10
11 BACKGROUND OF THE INVENTION

12 (1) Field of the Invention

13 The invention relates to a rotary pump system wherein a
14 rotary pump is driven by a drive means, and, more particularly,
15 is directed to a rotary pump ejection system for firing of
16 projectiles from submarines.

17 (2) Description of the Prior Art

18 Submarine rotary pump ejection systems are well known and
19 have been used onboard a large number of submarines of the U.S.
20 Navy. In FIG. 1, there is shown a prior art rotary pump system,
21 which includes a rotary pump 10 having an inlet 12 in
22 communication with a water supply, typically the ocean
23 environment of a submerged submarine. An annularly shaped outlet
24 14 leads to a holding tank (not shown) from whence the water is
25 admitted to the breech portion of a launch tube, such as a

1 torpedo tube, to force a projectile, such as a torpedo or
2 missile, out of the tube.

3 Connected to the rotary pump 10, by way of a coupling 16, is
4 a turbine 18 which serves as a drive means for the pump 10. The
5 turbine is driven by air under pressure, which is admitted to the
6 turbine by an air inlet valve 20 which is in communication with a
7 source 22 of high pressure air, typically from the vessel's air
8 head maintained at about 4,500 lbs/in².

9 In operation, the air inlet valve 20, which constitutes a
10 "firing valve" is opened to admit high pressure air to the
11 turbine. Stages of turbine blades in the turbine are caused to
12 rotate a turbine shaft 24 on which the turbine blade stages are
13 mounted. At the downstream end 26 of the turbine 18 there is an
14 air outlet 28 with a muffler 30 disposed therein. A speed sensor
15 32 is mounted adjacent the turbine shaft 24 and is adapted to
16 determine the speed of the turbine shaft 24, which equals the
17 speed of a rotary pump shaft 34, and communicates such determined
18 speed to a controller 36. The controller 36 is programmed with
19 selected speeds desired of the pump 10 throughout a launch cycle.
20 The controller 36 compares the determined speed received from the
21 speed sensor 32 with the programmed speed at that point in the
22 launch cycle and identifies any difference. The controller 36
23 then signals the air inlet valve 20 to adjust the admittance of
24 air to the turbine 18 to alter the speed of the turbine, to
25 thereby alter the speed of the pump. The speed monitoring
26 system, including the sensor 32 and the controller 36, operates

1 continuously during a launch to move the projectile through the
2 launch tube at appropriate speeds.

3 The above-described system, which is designed for modern
4 U.S. submarines, has performed well but has shortcomings which
5 must be addressed. The first is operational, in that there is a
6 built-in lag time between speed detection and speed correction,
7 based upon the fact that it takes time to adjust the firing valve
8 to charge the rate at which air is admitted to the turbine, and
9 time for the turbine speed to adjust to the modified supply of
10 air. A second problem is derived from defense budgetary demands.
11 The firing valve, which is a variable valve adapted to receive
12 and respond to electronic signals from the controller, is a very
13 expensive component of the system.

14 Thus, there exists a need for a better and less expensive
15 rotary pump speed control system.

16 17 SUMMARY OF THE INVENTION

18 An object of the invention is to provide a rotary pump
19 ejection system for firing of projectiles from submarines, the
20 system having facility for controlling the speed at which the
21 rotary pump rotates during a launch operation, such that the
22 velocity of the missile in its launch tube, during a launch
23 operation, is substantially equal to a desired velocity.

24 A further object of the invention is to provide means for
25 controlling the speed of the rotary pump in a manner which not

1 only accomplishes the desired control of pump speed, but does so
2 at a marked reduction in the cost of such control.

3 With the above and other objects in view, as will
4 hereinafter appear, a feature of the present invention is the
5 provision of a rotary pump system comprising a rotary pump, a
6 turbine for driving said pump, and a coupling interconnecting a
7 shaft of the turbine and a shaft of the pump. The invention
8 further includes a speed monitoring system for determining
9 rotational speed of the pump, the monitoring system being
10 programmed with selected speeds for the pump during operation,
11 and being adapted to send a signal indicative of a difference
12 between the determined speed and the programmed speed. The
13 invention still further includes a brake for engaging the
14 coupling, and a brake valve adapted to receive the signal from
15 the controller and, in response thereto, to operate the brake to
16 conform the speed of the pump shaft to the programmed speed.

17 In accordance with a further feature of the invention, there
18 is provided a rotary pump ejection system for launch of
19 projectiles from a submarine, the system comprising a rotary pump
20 for ejecting water for use in a launch tube to effect launch of a
21 projectile therein, an air turbine for driving the rotary pump,
22 and a coupling for connecting a shaft of the turbine to a shaft
23 of the rotary pump. The invention further includes a speed
24 monitoring system for determining rotational speed of the pump,
25 the monitoring system being programmed with selected speeds for
26 the pump during a missile launch, and being adapted to send a

1 signal indicative of a difference between the determined speed
2 and the programmed speed. The invention still further includes a
3 brake for engaging the coupling to slow the rotational speed of
4 the pump, and a brake valve adapted to receive the signals from
5 the speed monitoring system and to progressively engage the brake
6 with the coupling and disengage the brake from the coupling to
7 conform the speed of the pump to the programmed selected speeds.

8 The above and other features of the invention, including
9 various novel details of construction and combinations of parts,
10 will now be more particularly described with reference to the
11 accompanying drawings and pointed out in the claims. It will be
12 understood that the particular system embodying the invention is
13 shown by way of illustration only and not as a limitation of the
14 invention. The principles and features of this invention may be
15 employed in various and numerous embodiments without departing
16 from the scope of the invention.

17 18 BRIEF DESCRIPTION OF THE DRAWINGS

19 Reference is made to the accompanying drawings in which is
20 shown an illustrative embodiment of the invention, from which its
21 novel features and advantages will be apparent.

22 In the drawings:

23 FIG. 1 is a diagrammatical illustration of a rotary pump
24 ejection system of the prior art;

1 FIG. 2 is a diagrammatical view, similar to FIG. 1, showing
2 one form of rotary pump ejection system illustrative of an
3 embodiment of the invention; and

4 FIG. 3 is an enlarged sectional view of a coupling and brake
5 portion of the system shown in FIG. 2.

6 7 DESCRIPTION OF THE PREFERRED EMBODIMENT

8 Referring to FIG. 2, it will be seen that the illustrative
9 system includes the rotary pump 10 for ejecting water into a
10 holding tank from whence the water is admitted to a launch tube
11 (not shown) to effect launch of a projectile, such as a torpedo
12 or missile. The rotary pump 10 draws water, typically seawater,
13 in through the entry port 12 and discharges water through the
14 ejection port 14. Impellers 11 of the pump 10 are fixed to the
15 pump shaft 34, which turns with the impellers 11. In operation,
16 the pump impellers 11 are caused to rotate when a firing cycle is
17 initiated, as will be described herein below. Rotation of the
18 impellers 11 draws seawater in through entry port 12 and pushes
19 pressurized water out the ejection port 14, to the aforementioned
20 holding tank from whence the water, under pressure, is led into
21 the breech of a launch tube, to force the projectile out an open
22 end of the tube.

23 Referring still to FIG. 2, it will be seen that the
24 illustrative system includes a pump drive means 17, typically a
25 turbine 18 driven by high pressure air, which is taken from an
26 air source 22, preferably the submarine's air header (not shown)

1 maintained at about 4,500 p.s.i. The firing valve 20 is disposed
2 between the air source 22 and the turbine 18 and, when opened,
3 admits high pressure air to the turbine 18 to turn the turbine
4 18. The turbine 18 includes a number of stages mounted on a
5 turbine shaft 24. The turbine 18 at the downstream end 26
6 thereof, is provided with the air flow outlet 28 having the
7 muffler 30 therein.

8 Interconnecting the turbine 18 and the pump 10 is the
9 coupling 16 which comprises a pump coupling disc 25 fixed to a
10 pump shaft connector 27 mounted on the shaft 34 of the pump 10.
11 A detail view of the coupling 16 is provided in FIG. 3. The
12 coupling 16 further comprises a turbine coupling disc 29 fixed to
13 a turbine shaft connector 31 mounted on the turbine shaft 24.
14 Fixed to the pump coupling disc 25 and the turbine coupling disc
15 29, and disposed therebetween is an elastomeric ring 33. Thus,
16 rotation of the turbine 18 is transmitted from the turbine 18 to
17 the pump 10. In operation, when rotation of the pump 10 is
18 desired, to effect launch of a projectile, the firing valve 20 is
19 opened to admit pressurized air to the turbine 18, which turns
20 and which thereby drives the pump 10, to eject the water needed
21 to effect a launch.

22 In the course of a launch operation, the speed sensor 32
23 (FIG. 2) disposed adjacent the turbine shaft 24 determines the
24 speed of the turbine shaft 24, and thereby the speed of the pump
25 shaft 34, and thereby the speed of the pump 10. Preferably, the
26 turbine shaft 24 is provided with markings 35 (FIG. 3) and the

1 sensor 32 comprises a photocell 38 (FIG. 2) which is adapted to
2 input the speed of the markings and determine thereby the speed
3 of the turbine shaft 24. The sensor 32 is adapted to send a
4 signal indicative of the determined pump speed to the controller
5 36. Obviously, speed sensor 32 could be an induced magnetic
6 field proximity device or any other speed sensor.

7 The controller 36 is programmed with selected desired pump
8 speeds required to obtain desired projectile velocity throughout
9 the launch cycle. The controller 36 is adapted to receive the
10 signal from the speed sensor 32 and compare the speed determined
11 by the sensor 32 with the speed programmed in the controller 36
12 for that point in time, and note any difference between the
13 determined speed and the programmed speed. Based upon the noted
14 difference, the controller 36 sends a signal to a brake actuator
15 40 to actuate brake pads 42 of a brake assembly 48 to engage, or
16 release engagement with, the turbine disc 29 to alter the speed
17 of the pump 10.

18 The brake preferably is a hydraulic disc brake and the brake
19 actuator 40 preferably is a valve 44 disposed in a hydraulic line
20 46. The brake pads 42 are movable axially to progressively
21 engage the turbine disc 29 and to progressively disengage from
22 the disc 29, according to the operation of the brake valve 44.

23 Thus, in operation, the speed sensor 32 determines, for
24 example, the rotational speed of pump 10 and communicates that
25 determined speed to the controller 36. The controller 36
26 compares the determined speed with the programmed speed for that

1 point in time in the launch cycle, and identifies the difference,
2 as for example, a given excess in the speed. Based upon that
3 excess, the controller 36 signals the brake valve 44 to admit
4 hydraulic fluid to the brake 48. Upon admission of hydraulic
5 fluid to the brake 48, the brake pads 42 move into engagement
6 with the turbine disc 29, causing the pump 10 to slow. In short
7 order, the sensor 32 determines the new pump speed which is
8 signalled to the controller 36. The controller 36 compares the
9 new determined speed with the current programmed speed and
10 identifies, for example, equality. Thereupon, the controller 36
11 signals the brake valve 44 to close down on the supply of
12 hydraulic fluid to the brake assembly 48. The brake valve 44
13 follows the instruction of the controller 36 and the brake pads
14 42 are caused to back away from the disc 29. The determination
15 of pump speed by the sensor 32, the comparison of determined
16 speeds and programmed speeds by the controller 36, signals from
17 the controller 36 to the brake valve 44, and consequent operation
18 of the brake 48 is a continuous undertaking throughout the launch
19 cycle. At the end of the launch, the controller 36 orders the
20 firing valve 20 to close.

21 Thus, the firing valve 20 is essentially an "open or closed"
22 valve of relatively little expense. The brake system comprises
23 known components which are inexpensive compared to the expense of
24 the variable firing valves in the prior art. The system
25 presented herein therefore accomplishes all that the prior art

1 system accomplishes, improves upon control of projectile
2 velocity, and does so at considerably less expense.

3 It is to be understood that the present invention is by no
4 means limited to the particular construction herein disclosed
5 and/or shown in the drawings, but also comprises any
6 modifications or equivalents. For

7 example, while the invention has been described with respect to
8 submarines, it will be appreciated that the launch aspects of the
9 invention find utility in any undersea platform and that the
10 rotary pump brake aspects of the invention find utility in any
11 rotary pump assembly wherein speed control of the rotary pump is
12 critical. Further, while for illustrative purposes launch of
13 missiles and torpedoes has been discussed, it will be apparent
14 that launch of other devices, such as mines and special purpose
15 bodies, is contemplated.

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3 A ROTARY PUMP SYSTEM

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5 ABSTRACT OF THE DISCLOSURE

6 A rotary pump system includes a rotary pump, a turbine for
7 driving the pump, and a coupling interconnecting a shaft of the
8 turbine and a shaft of the pump. A speed monitoring system
9 determines rotational speed of the pump shaft, is programmed with
10 selected speeds for the pump during operation, and is adapted to
11 send a signal responsive to a difference between the determined
12 speed and the programmed speed. A brake is engageable with the
13 coupling, and a brake valve is adapted to receive the signal and,
14 in response thereto, to operate the brake to conform the speed of
15 the pump to the programmed speed.

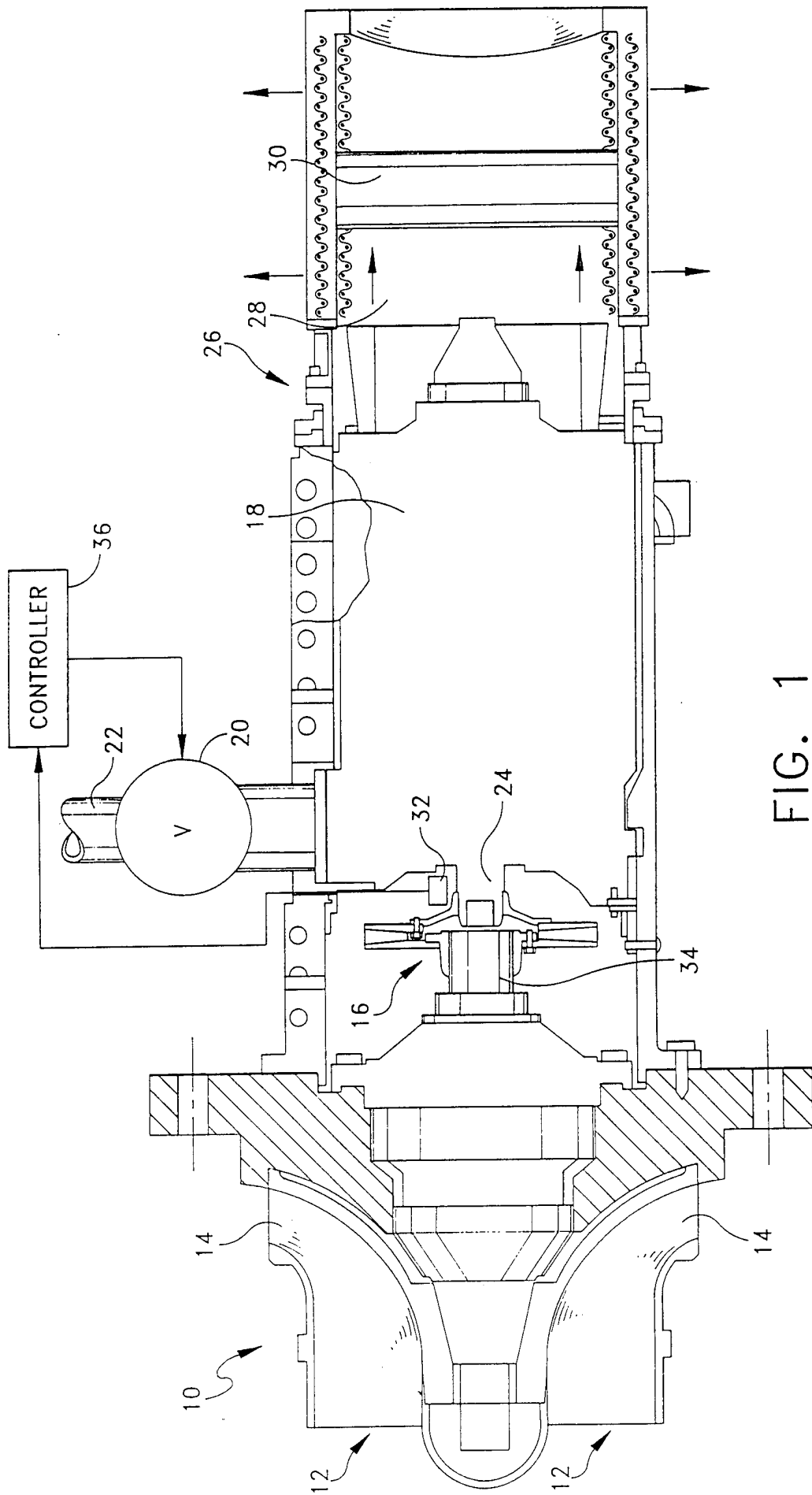


FIG. 1
 (PRIOR ART)

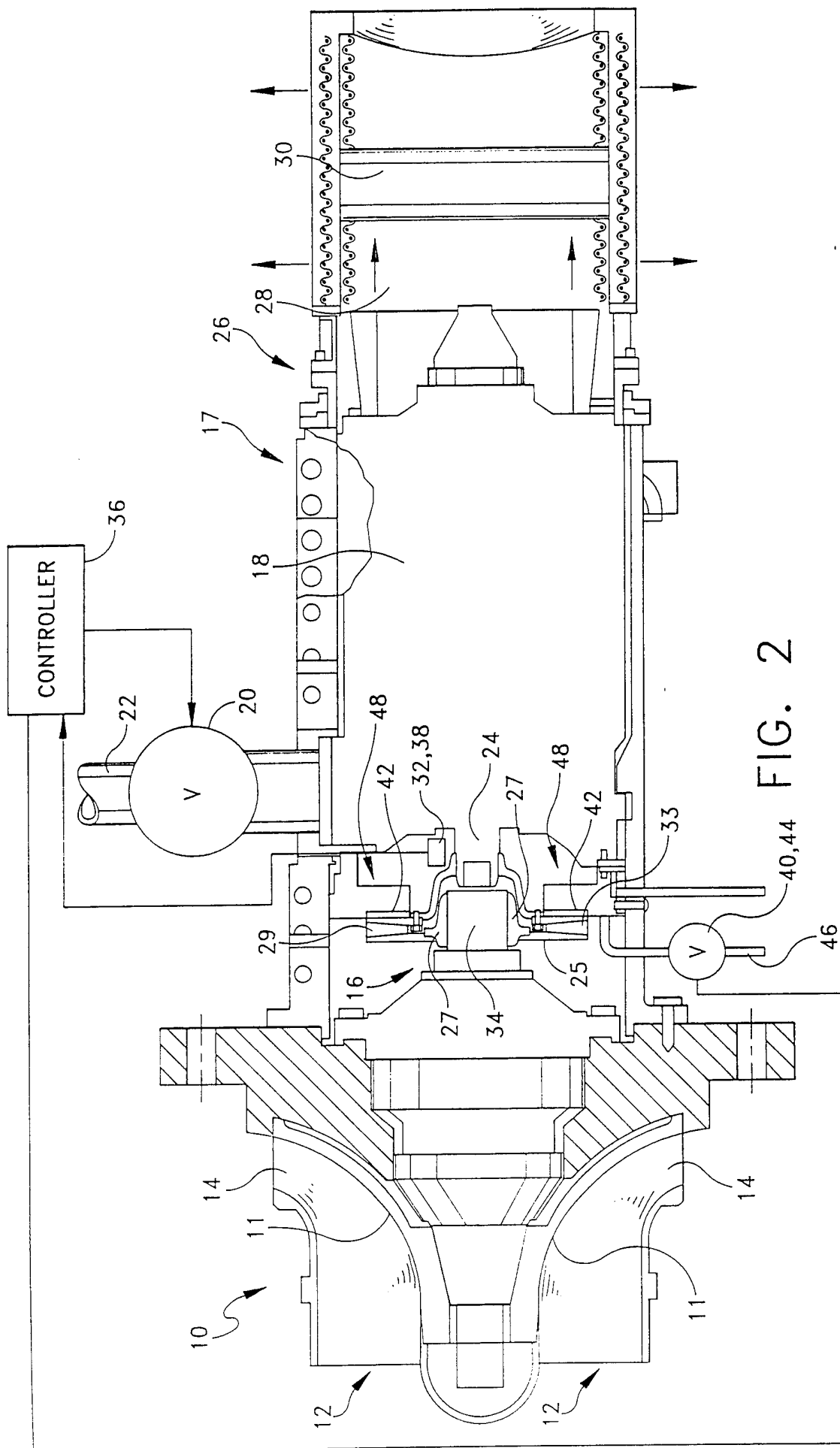


FIG. 2

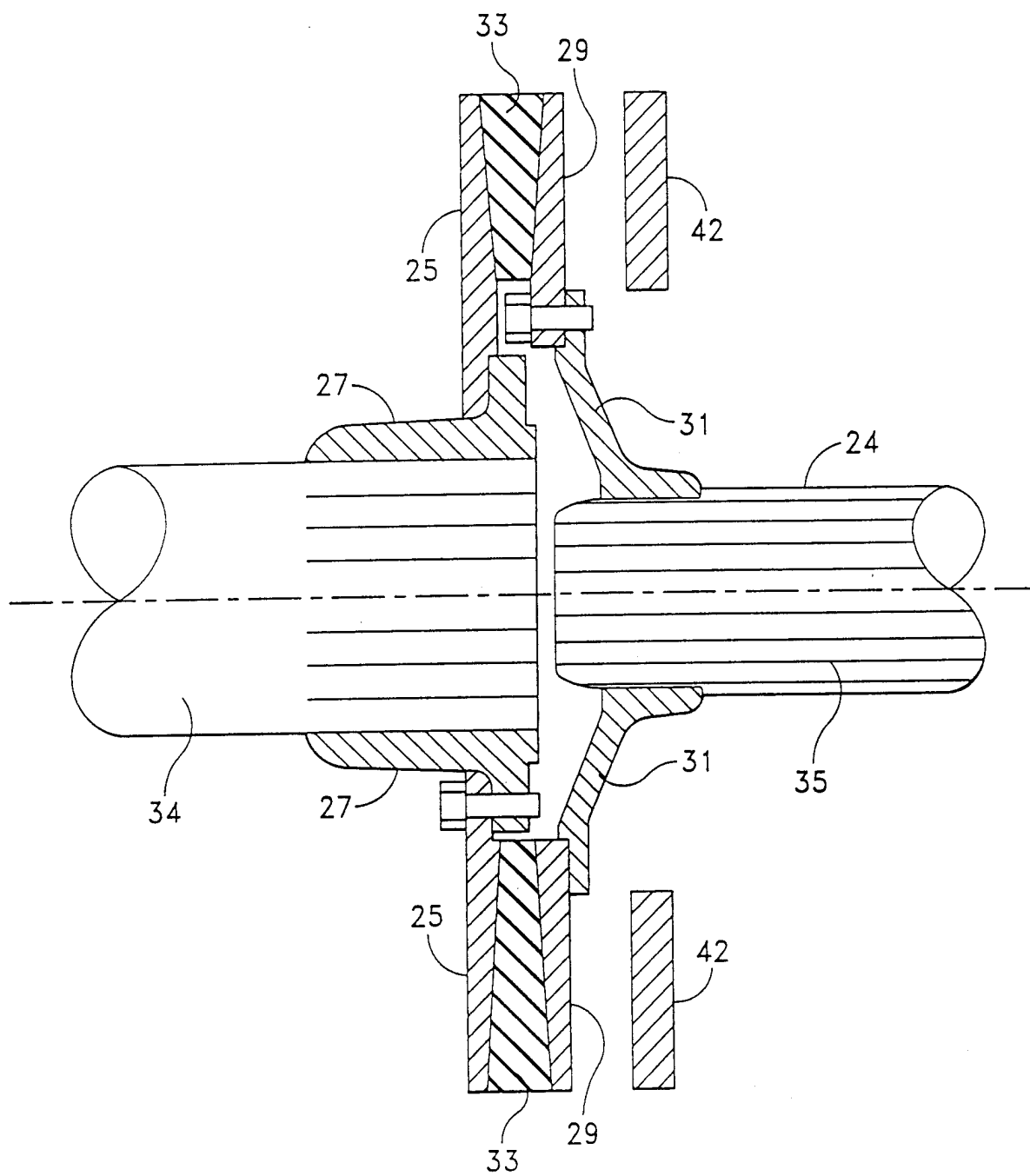


FIG. 3